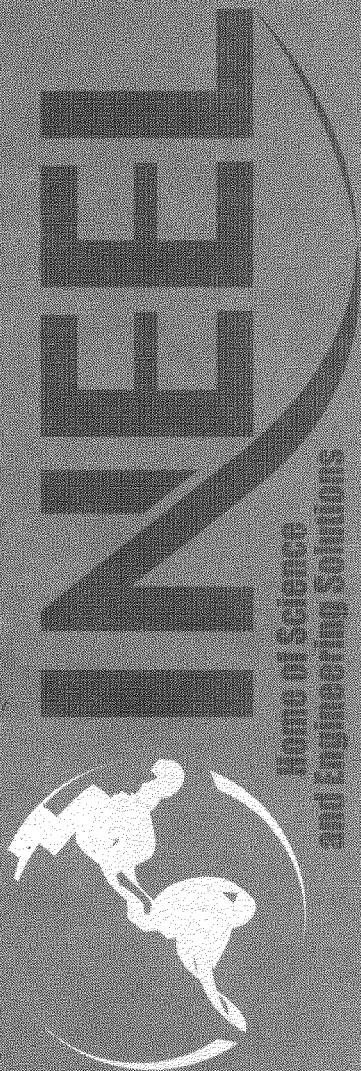


System Design Criteria for the OU 7-10 Glovebox Excavator Method Project

Process Design Criteria

October 2002



*Idaho National Engineering and Environmental Laboratory
Bechtel BWXT Idaho, LLC*

TFR-158
Revision 2
October 11, 2002

**System Design Criteria
for the OU 7-10 Glovebox Excavator Method Project
Process Design Criteria**

October 2002

**Idaho National Engineering and Environmental Laboratory
Environmental Restoration Program
Idaho Falls, Idaho 83415**

**Prepared for the
U.S. Department of Energy
Assistant Secretary for Environmental Management
Under DOE Idaho Operations Office
Contract DE-AC07-99ID13727**

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Approved by



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Oct. 1, 2002

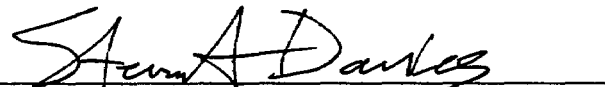
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ACRONYMS

DOE	U.S. Department of Energy
DOE-ID	U.S. Department of Energy Idaho Operations Office
EDF	engineering design file
FGE	fissile gram equivalent
INEEL	Idaho National Engineering and Environmental Laboratory
OU	operable unit
RCS	Retrieval Confinement Structure
RWMC	Radioactive Waste Management Complex
SDA	Subsurface Disposal Area
SDC	system design criteria
TFR	technical and functional requirement
WAG	waste area group

System Design Criteria for the OU 7-10 Glovebox Excavator Method Project

Process Design Criteria

1. INTRODUCTION

This system design criteria (SDC) document establishes the process design criteria for the Operable Unit (OU) 7-10 Glovebox Excavator Method Project. It is intended to augment the parent document, the *Technical and Functional Requirements for the Operable Unit 7-10 Glovebox Excavator Method Project* (INEEL 2002a), sufficiently to enable performance of the project's detailed design, engineering, and evaluation activities.

The *Record of Decision: Declaration of Pit 9 at the Radioactive Waste Management Complex Subsurface Disposal Area at the Idaho National Engineering and Environmental Laboratory, Idaho Falls, Idaho* (DOE-ID 1993) specifies the environmental remediation of transuranic waste from Waste Area Group (WAG) 7, OU 7-10. On October 1, 2001, the Idaho National Engineering and Environmental Laboratory (INEEL) published the *Waste Area Group 7 Analysis of OU 7-10 Stage II Modifications* (INEEL 2001), which identified a feasible approach for retrieving waste from OU 7-10. The OU 7-10 Glovebox Excavator Method Project was established to accomplish the objectives presented in that report. The overall objectives for the project are as follows:

- Demonstrate waste zone material retrieval
- Provide information on any contaminants of concern present in the underburden
- Characterize waste zone material for safe and compliant storage
- Package and store waste onsite, pending decision on final disposition.

This project is requested by the U.S. Department of Energy Idaho Operations Office (DOE-ID) in support of the *Federal Facility Agreement and Consent Order for the Idaho National Engineering Laboratory* (DOE-ID 1991), *Pit 9 Record of Decision* (DOE-ID 1993), *Explanation of Significant Differences for the Pit 9 Record of Decision at the Radioactive Waste Management Complex at the Idaho National Engineering and Environmental Laboratory* (DOE-ID 1998), and Appendix A of the *Remedial Design/Remedial Action Scope of Work and Remedial Design Work Plan: OU 7-10 (Pit 9 Project Interim Action)* (LMITCO 1997).

1.1 Facility Description

The INEEL is a U.S. Department of Energy (DOE) facility, located 52 km (32 mi) west of Idaho Falls, Idaho, and occupies 2,305 km² (890 mi²) of the northeastern portion of the Eastern Snake River Plain. The Radioactive Waste Management Complex (RWMC) is located in the southwestern portion of the INEEL. The Subsurface Disposal Area (SDA) is a 39-ha (97-acre) area located in the RWMC. Waste Area Group 7 is the designation recognized by the "Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA/Superfund)" (42 USC § 9601 et seq.) and in the *Federal Facility Agreement and Consent Order for the Idaho National Engineering and Environmental Laboratory* (DOE-ID 1991) for the RWMC, which comprises the SDA buried waste site. Waste Area

Group 7 has been divided into 13 OUs^a. Pit 9, designated OU 7-10, is located in the northeast corner of the SDA. The OU 7-10 site is an area in which chemicals, radioactive materials, and sludge from DOE weapons plants and other government programs were disposed. While such disposal at the RWMC began in 1952, OU 7-10 was used and filled in the late 1960s. The pit contains characteristic hazardous, listed hazardous, low-level radioactive, and transuranic waste.

The OU 7-10 Glovebox Excavator Method Project facilities and processes are being designed to safely conduct a waste zone material retrieval demonstration in a selected area of Pit 9. The project processes consist of excavation and retrieval; sampling, packaging, and interim storage; shutdown; deactivation, decontamination, and decommissioning; and environmental monitoring. Project facilities include a Weather Enclosure Structure, Retrieval Confinement Structure (RCS), excavator, ventilation system, and other supporting equipment. The packaged material will be stored onsite, pending decision on final disposition.

1.2 Limitations of the System Design Criteria

This SDC document defines the criteria for the process design aspects of the project. The SDC flow directly from the aforementioned technical and functional requirements (TFRs) and are intended to include detail not provided in the TFRs, client requirements, and those codes, standards, and regulations that will be used as a basis for developing the process design. Design criteria will be revised as the project proceeds.

This SDC document focuses only on the process design criteria. The SDCs for general structures and site, excavation, packaging, fire protection, facility and infrastructure, and instrumentation and control are addressed in separate documents.

1.3 Ownership of the System Design Criteria

This SDC document is the product of the combined activities of the project team. The project engineer has the ultimate responsibility for the content and approval of this document.

a. Operable Units 13 and 14 were combined in the comprehensive remedial investigation and feasibility study in 1995 (Huntley and Burns 1995).

2. OVERVIEW

2.1 Facility Structure, System, and Component Functions

The process represents the decision points, flow paths, and activity sequences of the operational tasks performed as part of the OU 7-10 Glovebox Excavator Method Project. Operations consists of all tasks performed to sample, excavate, retrieve, package, handle, transport, assay, and store all of the soil and waste materials to be removed from the designated portion of OU 7-10. The operations process consists of several subprocesses: overburden retrieval and packaging, waste retrieval and packaging, sample handling, and facility shutdown. Additional subprocesses for special cases may be required, but will be developed as needed during the operations activities.

A process team will lead the development of the process, with the assistance of an interdisciplinary team of appropriate subject matter experts. The process will be defined and presented via process logic diagrams and narratives, and process flow diagrams.

A dynamic and discrete event model will be developed and used to simulate the operations process. The model will provide insights and answers that otherwise would not be available until after the system was built and operations already underway. It will provide a solid, reliable basis for estimating an operational schedule. As the design and process are refined, the model will be modified to provide an updated schedule estimate and to assess the impact of design changes on the schedule. The model also will serve in evaluating scenario changes and process changes, and in performing trade-off analyses.

Mockup exercises and tests will be performed to provide inputs to the model and to verify the process design and the model representation.

2.2 Facility Structure, System, and Component Classification

No safety-class structures, systems, or components are associated with the OU 7-10 Glovebox Excavator Method Project.

The *Preliminary Documented Safety Analysis for the Operable Unit 7-10 Glovebox Excavator Method* (INEEL 2002b) provides a description of the facility safety basis and identifies its safety-significant design features. It prescribes minimum design criteria and functional requirements for the project. Structures, systems, and components affecting a particular system are discussed with that particular system.

2.3 Operational Overview

The project includes systems supporting retrieval and packaging of waste zone material. The site where the facilities will be located has 6-in. diameter probes that were installed to refusal during Stage I of the OU 7-10 Staged Interim Action Project. These probes may be moved during waste zone material retrieval, as necessary, to facilitate retrieval and underburden sampling operations. Overburden will be excavated and packaged before disturbing waste zone material.

A manned excavator will retrieve waste zone material. The operator will be located in the Weather Enclosure Structure outside the RCS. The excavator arm, contained within the RCS, will excavate an angular swath. The retrieved material in the excavator bucket will then be placed in a transfer cart. One transfer cart will be located at the entrance of each of the three material packaging gloveboxes. The carts will transport waste zone material into the gloveboxes, where it will be inspected, sampled, and packaged.

Packaged waste will then be assayed to determine total fissile mass. The waste will then be stored onsite, pending decision on final disposition.

After waste zone material excavation is complete and samples of the underburden are taken, the pit will be backfilled for closure before deactivation, decontamination, and decommissioning.

3. DESIGN CRITERIA AND BASES

3.1 General Process Design Criteria

3.1.1 Operational Design Criteria

This section contains the operational design criteria for the general process. These operational design criteria are applicable to all processes identified in this section, in addition to those listed specifically in the subsection:

1. The OU 7-10 Glovebox Excavator Method process shall be performed on a 24-hour day, 7-day week shift.

Basis: Management decision to reduce project risk, by minimizing exposure (i.e., minimizing the amount of time that the pit is open).

2. The excavator subsystem shall conduct one retrieval campaign.

Basis: TFR Section 3.1.1.1-3; *Waste Area Group 7 Analysis of OU 7-10 Stage II Modifications*, October 1, 2001, Section 1.3, "Background." Applications of the system design were reduced from five to one. There will be no relocation of the system.

3.1.2 Accident Design Criteria

Accident design criteria for the general process are addressed specifically for each subprocess in the following subsections.

3.1.3 Safety-Significant Items

No safety-significant items have been identified for the project's general processes. Safety-significant items are identified under the applicable design criteria sections.

3.1.4 Applicable Regulatory and Contractual Requirements

No applicable regulatory and contractual requirements have been identified for the project's general process.

3.1.5 Applicable Industry Codes and Standards

No applicable industry codes and standards have been identified for the project's general process.

3.2 Overburden Retrieval and Packaging

3.2.1 Operational Design Criteria

In addition to the operational design criteria identified for general processes, the following operational design criteria are specific to the overburden process:

1. Overburden shall be retrieved, packaged, and removed from the RCS before beginning excavation of the waste zone material.

Basis: TFR Sections 3.1.1.2-1, 3.1.2.1-1, and 3.1.2.1-6. The overburden soil overlays the waste zone, and the waste zone cannot be reached until the overburden has been removed. Completing overburden removal before beginning waste retrieval minimizes cross contamination of the overburden soil. The *Waste Area Group 7 Analysis of OU 7-10 Stage II Modifications*, October 1, 2001, Section 4.3, "Process Description."

2. Overburden soil shall be excavated until one of the four following criteria are met:

- A predefined depth (currently 3.5 ft below grade) is reached
- Physical waste zone material is encountered (e.g., a drum remnant or bag), regardless of contamination level
- Contamination levels are encountered above Radiological Control's prescribed thresholds.
- Hard pan is encountered (i.e., waste seam).

Basis: TFR Sections 3.1.2.1-2, 3.1.2.1-5, 3.1.2.2-1, and 3.2.2-3. Safety—to reduce the potential of exposing hazardous or radioactive waste prematurely. The *Waste Area Group 7 Analysis of OU 7-10 Stage II Modifications*, October 1, 2001, Section 4.3, "Process Description."

3. If waste zone material or contamination above threshold limits is found in the overburden, the area shall be covered over and excavation shall continue in the next overburden section.

Basis: TFR Sections 3.1.2.1-2 and 3.1.2.1-6. Safety—to reduce the potential of exposing hazardous or radioactive waste prematurely. Threshold limits will be defined in the operating procedures.

4. Overburden material shall be packaged in 4 × 4 × 4-ft soil sacks.

Basis: TFR Sections 3.1.2.5-1, 3.1.2.5-2, and 3.1.2.5-3. Engineering judgment—to reduce complexity, schedule, and production of emptied drums that will require subsequent disposal or decontamination after the soil has been returned to the pit.

5. The process shall be designed to handle 50 soil sacks.

Basis: Overburden consists of approximately 70 yd³ of material. Factoring in packaging efficiency and fluffing, this amount of soil will require forty-five 4 × 4 × 4-ft soil sacks. These calculations are documented in the *OU 7-10 Glovebox Excavator Method Process Calculations* (Walsh 2002).

6. Overburden retrieval shall be accomplished by excavator and manual digging, with personnel inside the RCS.

Basis: TFR Section 3.2.8-1: Simplification for reduction of cost and schedule. Technicians in confinement will dig soil around probes and move the soil sacks.

3.2.2 Accident Design Criteria

The following accident design criteria are specific to the overburden subprocess:

1. If unacceptable airborne contamination levels are created during overburden retrieval, operations shall cease until contamination control is restored.

Basis: TFR Section 3.1.1.1-5; DOE O 420.1, Section 3.1.1.2 (3.), Section 3.1.2.1 (2.) and (7.), Section 3.2.2 (1.) and (3.), Section 3.2.7 (1.) and (2.), and Section 3.3.5 (1.) and (2.) - Worker and Public Safety.

2. If contamination levels cannot be controlled within threshold limits, overburden retrieval shall cease and the waste zone material process shall retrieve the remaining material.

Basis: Worker and public safety TFR Section 3.1.2.1-2, 3.1.2.1-5, 3.2.2-1, and 3.2.2-3. Threshold limits will be defined in the operating procedures.

3.3 Waste Retrieval and Packaging

In addition to the operational design criteria identified for general processes, the following operational design criteria are specific to the waste zone material process:

1. The process shall be designed to handle five hundred-fifty 55-gal drums of waste and sixty 85-gal drums of debris.

Basis: TFR Section 3.1.2.1-3 requires retrieval of 75 to 125 yd³ of waste. For a 52-degree angle of repose, 80 yd³ of waste zone material will be retrieved. Factoring in packaging efficiency and fluffing, this material will require three hundred-fifty 55-gal drums and fifty 85-gal drums. Packaging efficiency decreased from an anticipated 5.8 ft³ per drum to an actual 4.5 ft³ per drum.

2. The process shall, where practical, be designed for generating six drums of waste per shift.

Basis: This rate is a target only and not a hard requirement. Operations costs are roughly \$150,000 per day; therefore, efficient operation is critical to managing cost.

3. Uncontained free liquid encountered in the gloveboxes shall be stabilized before packaging.

Basis: TFR Section 3.1.2.2-4. Free liquids are both short- and long-term hazards in the storage of hazardous materials and require solidification and stabilization. The Resource Conservation and Recovery Act definition of, and test for, free liquids would require testing in excess of what the Agencies agreed would be appropriate for short-term storage of project wastes. It was agreed that it would be adequate to stabilize only free liquids during visual inspection during the course of retrieval, sorting, sampling, and repackaging.

4. Fissile material monitoring shall be performed on material suspected of containing high fissile material content to prevent overloading of final storage package. Suspect material shall be focused specifically on filter media.

Basis: TFR Sections 3.2.2-3, 3.2.3-1, 3.2.3-2, and 3.2.3-3 - Safety and Storage Requirements. The overloaded fissile material limit is 380 g per drum with the operational limit set at 200 g. Suspect material is based on the Criticality Safety Evaluation. The only known material with sufficient fissile material concentration to potentially create an overloaded drum is filter media. Only material known to be, or suspected to be, filter media is

required to be monitored to quantify fissile content before packaging. This material is defined as combustible (fibrous) material that cannot be readily identified as something other than filter media, such as clothing and rags.

5. Monitored material containing up to 100 fissile gram equivalent (FGE) Pu shall be disposed of with the associated waste batch.

Basis: TFR Sections 3.2.2-3, 3.2.3-2, and 3.2.3-3. Final fissile limits are published in EDF-1972, *Estimated OU 7-10 Target Area Fissile Material Inventories based on the Analysis of SWEPP Radioassay Data* (Akers and May 2002). The overloaded fissile material limit is 380 g per drum with the operational limit set at 200 g. Some waste streams will be identifiable through process knowledge and should not produce overloaded drums. Other waste streams need to be monitored as drums are loaded to ensure compliance with fissile loading limits. Certain waste streams, if overloaded, lead to difficult operational recovery processes in order to be repackaged. Details regarding disposition of fissile monitored material are addressed in EDF-2492, *Disposition of Fissile Monitored Material for the OU 7-10 Glovebox Excavator Method* (Borland 2002).

6. Material exceeding 100 FGE Pu shall be segregated and packaged separately or subdivided into multiple components that contain less than 100 FGE Pu.

Basis: TFR Sections 3.2.2-3, 3.2.3-2, and 3.2.3-3. Final fissile limits are published in *Estimated OU 7-10 Target Area Fissile Material Inventories based on the Analysis of SWEPP Radioassay Data* (Akers and May 2002). The overloaded fissile material limit is 380 g per drum with the operational limit set at 200 g. Some waste streams will be identifiable through process knowledge and should not produce overloaded drums. Other waste streams need to be monitored as drums are loaded to ensure compliance with fissile loading limits. Certain waste streams, if overloaded, lead to difficult operational recovery processes in order to be repackaged. Details regarding disposition of fissile monitored material are addressed in EDF-2492, *Disposition of Fissile Monitored Material for the OU 7-10 Glovebox Excavator Method* (Borland 2002).

7. Waste zone material shall be packaged in 55-gal drums.

Basis: TFR Sections 3.1.1.2-1, 3.1.2.4-1, and 3.1.2.4-3—compatibility with intended waste storage facilities. Safe and cost-effective storage and transport of hazardous materials requires packaging in standard waste containers.

8. Metal drum remnants, which cannot fit in 55-gal drums, may be packaged in 85-gallon drums to avoid the need for sizing operations.

Basis: TFR Sections 3.1.2.1-4, 3.1.2.4-1, and 3.1.2.4-2—to avoid timely and hazardous resizing activities. Safe and cost-effective storage and transport of hazardous materials requires packaging in standard waste containers.

9. Waste generated by collecting the sample shall be packaged with its associated source material.

Basis: TFR Section 3.5.5-3—to prevent generation of additional waste streams requiring separate handling.

10. Waste shall be packaged to prevent fissile material interaction.

Basis: TFR Sections 3.2.3-1 and 3.2.3-2 – Safety

11. Drums shall be staged after filling and before assay with 16 in. spacing edge-to-edge between drums to prevent neutron interaction.

Basis: TFR Section 3.2.3-1– Safety Criticality Basis. The spacing requirement is identified in the Criticality Safety Evaluation.

12. Packaged waste shall undergo final drum assay to determine fissile content prior to being placed in onsite storage.

Basis: Final drum assay is necessary to support safe storage.

13. Incompatible materials shall be packaged and stored in accordance with substantive requirements of applicable or relevant and appropriate requirements.

Basis: TFR Section 3.1.1.3-2 – Safety. See also the *Glovebox Excavator Method Project Storage Requirements and Approach* (Burton 2002).

14. Retrieval, packaging, and storage processes shall be capable of conveying contained liquids, sludge, and solids between process areas.

Basis: TFR Section 3.1.2.2-2. See also the *Glovebox Excavator Method Project Storage Requirements and Approach* (Burton 2002).

15. Material encountered outside the established operating bases may be left in the retrieval area. (Examples include large and heavy items, radiation sources greater than 200 mR contact, drums, and drum remnants with concrete, etc.)

Basis: *Waste Area Group 7 Analysis of OU 7-10 Stage II Modifications*, October 1, 2001, Section 4.3, “Process Description.”

16. Retrieved outlier material may be “bagged out” and disposed of independent of the regular waste zone material process, depending on unreviewed safety question evaluation.

Basis: *Waste Area Group 7 Analysis of OU 7-10 Stage II Modifications*, October 1, 2001, Section 4.3, “Process Description,” and Appendix A, “Assumptions,” A.1.1, fifth paragraph, which describes outlier materials.

17. The retrieval end state shall be comprised of the following conditions:

- A minimum of 75 yd³ of waste zone material has been excavated within the retrieval area
- The retrieved waste zone material has been assayed, determined to be less than 200 FGE per drum, and sent to onsite storage
- The retrieved waste zone material has been sampled
- The exposed underburden below the retrieval area has been sampled

- Security has reviewed the last of the glovebox record of handling videotapes and all suspect security items have been dispositioned
- DOE has provided a Notification of Completion of Stage II Excavation to the Agencies
- The disposition path has been identified for all outliers encountered during excavation and all items will be in safe/compliant storage or dispositioned.

Basis: CDR Section 3.1.6; TFR Sections 2.3, 3.5.3-4, and 3.5.3-5; DOE Order 435.1, “OU 7-10 Glovebox Excavator Method Project Physical Security Plan.”

3.4 Sample Handling

Sampling and analysis activities are outside the scope of this document (i.e., Process System Design Criteria document). These activities are addressed in the Field Sampling Plan (reference TFR Section 3.1.2.3).

3.5 Facility Shutdown

The following operational design criteria are specific to the facility shutdown process:

1. The operation end state shall be comprised of the following conditions:

- Loose contamination has been fixed to prevent migration
- Pit area has been backfilled
- Facility is in safe shutdown state ready for transfer to Decontamination and Dismantlement.

Basis: CDR Section 3.1.6; TFR Sections 2.3, 3.5.3-4, and 3.5.3-5.

2. The Stage I probes removed during excavation shall remain in the pit during backfill.

Basis: TFR Section 3.2.8-1.

3. Pit backfill shall be placed to minimize void spaces with the exception of the insides of the Stage I probes.

Basis: *Waste Area Group 7 Analysis of OU 7-10 Stage II Modifications*, October 1, 2001, Section 4.3.2, “Schedule Estimate, Closeout.” Closeout encompasses those activities necessary for placing the facility in safe shutdown. The excavation will be stabilized by backfilling after waste retrieval and before passive safe shutdown at closure.

4. Pit backfill shall be water permeable and not interfere with the natural drainage of the area.

Basis: *Waste Area Group 7 Analysis of OU 7-10 Stage II Modifications*, October 1, 2001, Section 4.3.2, “Schedule Estimate, Closeout.” Closeout encompasses those activities

necessary for placing the facility in safe shutdown. The excavation will be stabilized by backfilling after waste retrieval and before passive safe shutdown at closure.

5. The OU 7-10 Glovebox Excavator Method Project facility shall be placed in a safe lay-up condition for up to 1 year, which will provide for freeze protection and maintaining confinement of contaminants.

Basis: *Waste Area Group 7 Analysis of OU 7-10 Stage II Modifications*, October 1, 2001, Section 4.3.2, "Schedule Estimate, Closeout." Closeout encompasses those activities necessary for placing the facility in safe shutdown. The excavation will be stabilized by backfilling after waste retrieval and before passive safe shutdown at closure.

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